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ON CHRONIC ARSENIC POISONING, ESPE- CIALLY FROM WALL-PAPER,

BASED ON THE ANALYSES OF TWENTY-FIVE CASES IN
WHICH ARSENIC WAS FOUND IN THE URINE.¹

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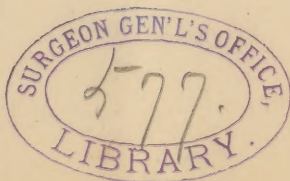
THE object of this paper is to call attention once more to the prevalence of poisoning from arsenical wall-papers, by reporting brief notes of twenty-six cases, which have never been published, where arsenic was found in the urine. I have chosen this series of cases, not because they are clinically more striking than many others where the urine was not examined, but because they may be justly expected to carry more weight, since through the demonstration of the arsenic one element of doubt as to the diagnosis is removed.

For the notes of twenty-four of the cases I beg to express my sincere thanks to the following gentlemen : Profs. Wood and Hills, Dr. A. M. Comey, and Mr. W. S. Robinson, of Harvard University, Prof. Sanger, Drs. S. W. Driver, S. W. Torrey, T. E. Francis, E. F. Cutter, A. Worcester, T. M. Rotch, P. C. Knapp, J. T. G. Nichols, and Prof. H. B. Hill.

I wish also to make a contribution toward our means of exact diagnosis in this obscure class of cases by calling special attention to one where a close examination showed the presence of a neuritis which might readily have escaped detection.

I shall have occasion to refer frequently to a

¹ Read at the meeting of the Boston Society for Medical Improvement, February 12, 1889.



series of observations by Kirchgasser (1868), partly because he has utilized his material in a very thorough manner, for the benefit of diagnosis, partly because in his cases also the diagnosis was in many instances controlled by an analysis of the urine.

The time has nearly gone by when fair-minded persons who have taken pains to investigate the evidence need to be convinced that arsenical wall-papers and fabrics may be a source of poisoning. The problems of chief importance at present are, how we may learn to recognize with greater confidence the less typical cases; how we may persuade our legislators to give us due protection against this wide-spread public danger. The latter need has recently been pointed out anew by a writer (Mr. A. W. Stokes) in the London *Chemical News*, to whose investigations attention is called in the last number (January, 1889) of the *Therapeutic Gazette*. The author examined one hundred samples of Indian muslins and cretonnes, and found that 23 per cent. contained arsenic in appreciable quantities, the highest percentage being twenty-three grains of white arsenic per square yard. Arsenic was also found in 10 per cent. of wall-papers submitted by various manufacturers, and in a number of other articles of household use. It has been asserted by our chemists that the dangers from these sources are by no means so great as formerly, but it is evident that they are still far from being entirely done away with.

The symptoms which are liable to be met with in these cases are so thoroughly detailed in the admirable reports of Drs. Draper and Wood, in the Massachusetts State Board of Health reports for 1872 and 1885, and by the writers therein cited, as to make it seem a needless task to call

attention to the subject afresh, especially as it might be thought unwise to separate the discussion of the symptomatology of this special form of arsenic poisoning from that of chronic arsenic poisoning in general. As a matter of fact, however, it is mainly from this class of cases that we practically derive our knowledge of chronic arsenic poisoning, and our power of diagnosis of this condition is by no means perfect. Acute arsenical poisoning has long been familiar to toxicologists, and the subacute form is usually easily recognized by the severe gastro-intestinal disorders, œdema of the eyelids, outspoken affections of the mucous membranes, sensory and motor paralyses, and the like; but in dealing with the chronic forms we have only the shadows of these characteristic symptoms to guide us, and are, moreover, likely to be led astray by the fact that the arsenic may only act by bringing out the latent weaknesses of the patient. For this reason, we not only need to know that a particular symptom may be of arsenical origin, but also to familiarize ourselves with more refined methods of ascertaining whether it is so or not. Of such symptoms, the most convincing are perhaps those that can be recognized by physical examination, such as neuritis of a sufficiently advanced degree to cause changes in electrical reaction, diminution of cutaneous sensibility, impairment of motor power or co-ordination. Another physical sign, which is spoken of as important by Kirchgasser, is a peculiar browning of the skin, especially of the face. This has often been described as occurring during the long-continued use of arsenic for medicinal purposes, but not often in connection with wall-paper poisoning. It probably affects other parts of the body quite as much as the face. It is the same

writer's opinion that a typical periodic recurrence of symptoms is frequently seen, suggesting the intermittence of malaria, and certain neuralgias ; and he also points out that shifting rheumatoid. Another important physical sign is albuminoia with casts and sometimes blood in the sediment ; of this I have two instances to report. The other influences which might lead to this condition are not numerous, and can, after a time at least, usually be eliminated.

In Kirchgasser's cases this symptom was not present, and he says, in fact, that the urine is not characteristic, though he dwells upon the significance of dysuria. Both those symptoms have been noted by other writers, especially from poisoning with arseniuretted hydrogen.

Cerebral symptoms, such as vertigo, impairment of memory and mental endurance, and, rarely, epileptiform seizures, are met with in cases of chronic arsenical as in lead poisoning, and may be suggestive if not characteristic, if other causes can be excluded. Kirchgasser further reports, as others have done also, attacks of fever of low grade and unusual course, and this is noted in one of my cases.

The case observed by myself is as follows :— The patient is a lady forty-three years of age, and of naturally good health and habits. She is a hard worker, and during the year or two previous to the illness now in question, suffered from time to time with severe colds and indigestion, which, however, yielded, after a while, to careful dieting and tonics. At the time that the symptoms began, she was in good condition, and had, in fact, only recently returned from a vacation. In the spring of 1887, shortly before going on her summer vacation, she moved into new lodgings, which consisted of eight rooms. About a month or six weeks after returning

home, she began to suffer from severe pain in the abdomen, at the epigastrium. This pain recurred periodically, coming on in the morning and passing away in the afternoon. It was unconnected with any sign of digestive disorder except intestinal flatulence, and was not relieved by the most stringent dieting, nor by medicinal treatment; but was somewhat relieved by a full meal. This pain remained without material change through the autumn, winter, and the following spring, unaccompanied at first by any other sign of illness, except that the patient felt fatigued after the attacks and finally began to lose sleep and appetite. About February or March, 1888, she first noticed tingling in the fingers, lips, tongue, and a slight twitching of the fingers on attempting to write. The right hand was worse than the left. These symptoms continued with varying intensity for many months. The feet were affected in a similar manner, at first in a less degree than the hands, but towards the end of June more severely. She also after a time began to be troubled with soreness of the hands and wrists on pressure, so that she dreaded to shake hands; and writing, which had formerly been easy and habitual, became a labor from which she shrank. There was also lameness about the left shoulder, developed by any slight blow.

The drinking water and urine were examined for lead, at this period, but none was found. Moderate pressure on the arms, as in lying on the side, and even at times in the back, caused a sense of formication, so uncomfortable that she frequently refrained from lying down.

I would here remark that this "going to sleep" of the arms on lying down, even when the arms themselves are not under the body, is a familiar

symptom to neurologists, and is generally attributed to slight neuritis, though it is not proved that this is always present.

The same sensation was readily excited in the legs by crossing one over the other. A careful electrical examination made on August 4, 1888, showed that the minimal faradic action of some of the extensor muscles of the fingers, as well as of the opponens and flexor proprius pollicis, were less good for the right arm than the left, requiring the coils to be approximated about half a centimeter for that side.

The figures are as follows:—

	R.	L.
Fl. prop. pol.	12.	12.5
Opp. pol.	11.5	11.9
Ext. lon. ind.	10.8	11.2
Ext. com. dig.	10.8	10.8
Ext. min. dig.	10.8	11.2
Ext. carpi uln.	11.	10.6

The results of this examination were essentially the same with that of a previous examination of the date of July 16th, and at that time a similar, slight, but definite difference of reaction to the galvanic current, in favor of the left side, had also been made out. When stronger currents were used it was found that while the extensor muscles of the left forearm responded strongly, so that the hand and fingers were raised in the usual manner, those of the right arm did not contract with corresponding vigor, their contraction being readily overcome by that of the flexor muscles, though the latter were stimulated only by the current transmitted through the thickness of the arm, so that when the electrode was placed over the extensors, and strong currents applied, the hand was flexed instead of being extended. This was confirmed by repeated trials. The difference in reaction between the two arms

was not due to greater electrical resistance on the right side, as was shown by galvanometric tests. The grasp of both hands was feeble, that of the left especially so. The dynamometer figures were, R. 5; L. 17, whereas they might have been expected to be at least R. 40 to 50; L. 30 to 40.

On hyperextension of the hand and fingers, with the fingers spread, there was a marked tremor of both hands; but while the left hand could be held extended by a strong effort, the right began almost immediately to droop, and reached the plane of the forearm after thirty or forty seconds. I consider this to be a sign of real value in estimating slight failure in efficiency of the extensor muscles, not severe enough to betray itself in the ordinary use of the hands.

The sensibility of the tips of the fingers of the right hand, as compared with the left, was found slightly but markedly diminished, on careful testing, as regards touch and temperature and estimation of the compass points (R. 3-16, L. 2-16).

In the early part of July the wall-papers were examined by Dr. A. M. Comey, of Harvard University, and a large quantity of arsenic was found in two of them, which covered the walls of the rooms. The largest quantity was in the room used by the patient as a bedroom. Early in August the urine was also analyzed, and Dr. Comey reported that it contained as large an amount of arsenic as he had ever found in a urine analysis.

Almost immediately after this (in July) the patient moved to new lodgings, and for safety's sake the paper on the patient's bedroom was examined for arsenic. The patient is away all day long, and is practically never in any other room except the parlor, where she sits a few hours in the evening

five days in the week. A large amount of arsenic was found in the bedroom paper, and the room was repapered in October, but unfortunately the new paper was put on over the old. For a few weeks before this change was made the patient had had less pain and discomfort in the arms, perhaps as a result of leaving her former lodgings, but from this time forward her improvement in every respect was almost continuous, although on one occasion, during a visit away from home, the pain in the stomach returned.

During the entire present winter she has remained (except for an occasional twinge) free from the pain in the stomach which had followed her so long and so continuously. For a long time, however, and until four or five weeks ago, she suffered from constant nightmares and slept restlessly and poorly.

In November the urine was examined for the second time, and arsenic was still found in considerable quantity, though not so much as before.

I advised her to have both papers removed from the wall, and asked her before doing so to have a third analysis of the urine made, in order to see whether the arsenic found the second time was probably due to the underlying paper, or was an indication that the elimination from the previous poisoning was not complete.

This has been done, with the result that a very large amount has been found to be still present. The idea naturally suggests itself that she is getting arsenic from some other source, but if so I have been unable to find it. Her household effects are very limited, and of the few articles in her possession which might be suspected, I have had a dress and a curtain analyzed, and pieces of two carpets, as well as the paint of the room in which

she works, with the result that all of them were found innocent.

One other symptom remains to be mentioned, though I am not prepared to assert that it is attributable to the arsenic.

Namely, during last autumn, at about the time of the repapering of the bedroom, and while the gastralgia was abating, the patient began to suffer from a typical convulsive spasm of the left facial muscles, which at times was severe, and this has continued, with a few weeks' intermission, up to the present time. I shall bring forward evidence to show that the action of arsenic may probably be concentrated in one part of the body, apparently causing, or helping to cause, localized and unsymmetrical signs of disease, but in the present case the patient remembers having noticed a very slight twitching about the left eye and left angle of the mouth shortly before she moved into the first lodgings, at a time when she is not known to have been exposed to arsenic, and doubt is thus thrown on the propriety of referring the spasm to arsenical poisoning, though the patient herself considers the former attack to have been of a different nature from this. Except for this facial spasm the patient is now apparently in good health.

The figures for the dynamometer test are now R. 35; L. 35.

The points that seem to me chiefly important in this case are that, in spite of the absence of any material disorders of the general nutrition, or the digestion, the attacks of gastralgia recurred daily, and at the same hour, for almost a year; and, still more, that definite signs of loss of muscular strength, affecting the extremities the most, and both flexor and extensor muscles, impairment of cutaneous sen-

sibility, and changes in the electrical reactions were found on careful examination, though the patient had not been incapacitated for work, and her symptoms were such as might easily have been attributed to simple nervous weakness.

With regard to the diagnosis, the absence, so far as is known, of other causes of generalized neuritis; or of any history of previous attacks of gastralgia or analogous nervous symptoms; and the improvement when the patient was removed from exposure to the worst arsenical paper, together with the finding of arsenic in the urine, warrants us in looking upon arsenical poisoning as the most probable origin of her illness. The continued presence of arsenic in the urine renders it probable that the poison is still given off in spite of the overlying paper, or comes also from the other papers which have not been analyzed.²

The remainder of the twenty-five unpublished cases in which arsenic was found in the urine are in outline as follows:—

Case 1 was reported to me by Drs. A. Worcester, and E. C. Cutler, of Waltham, the analyses being made by Prof. Hill, of Cambridge. The patient was a woman, thirty years of age, whose health had previously been good. The symptoms were briefly as follows: indigestion of several years' standing; debility, especially for a few weeks each spring and fall, after house-cleaning; in March, 1887, tonsillitis for two months following; coated tongue, salivation, with swelling of the sublingual and submaxillary glands, increased by mastication; nausea; loss of flesh, but no headache or diarrhœa. Arsenic poisoning was suspected, mainly on account of the salivation, and the patient was sent away from home for

² Since this period the patient has had a short illness, in which the gastralgia returned for a time.

a few days, during which the gastric symptoms, salivation and swelling of the glands, became worse. The urine was examined and 0.02 mg. to the litre found. The wall-papers were also examined with the following result:—

Sitting-room.....	trace.
Bedroom	0.002 milligrammes to square meter.
Hall	0.027 " "
Spare room.....	0.420 " "
Curtains	trace.

The spare-room was almost constantly kept open, though rarely used. The patient remembered having felt worse at one time after sleeping there for a few weeks, and that room had always been included in the house-cleaning. The case finally ended in recovery, but not until the patient had made a prolonged stay away from home, and all the articles *containing even a trace of arsenic* had been removed. The salivary symptoms remained troublesome the longest.

Case 2. Husband of the above. His symptoms also consisted in salivation, with swelling of the glands; and he eventually recovered.

This is one of those interesting pairs of cases sometimes met with where a similar exposure gives rise to similar symptoms, the diagnostic value of which is thereby materially increased. They are also interesting on account of the prominence of the salivary symptoms, and because in the first case the symptoms continued to grow worse for a time after removal from exposure, and because a susceptibility to even traces of arsenic seemed to be gradually established.

Nos. 3 and 4 are two interesting cases, also of husband and wife, reported by Dr. S. W. Torrey, of Beverly, the analyses being made by Prof. Wood. Here again both patients presented essentially similar symptoms. In the case of the wife these symptoms

consisted in long-continued muscular pains, especially in the shoulders and arms, of increasing severity, together with insomnia, prostration, and with some impairment of the digestion, but without diarrhœa, or disease of the superficial mucous membranes. In the case of the husband, prostration, insomnia, and indigestion were also present, and the tongue showed the silvery coat so often alluded to by other observers. Arsenic was found in quite a number of fabrics and papers, mostly in small amounts, but in a dress and in the frieze of the sitting-room in a large amount.

After removal of the papers and fabrics (except one carpet), and a vacation in the woods, the patient improved, but on his return relapsed and was attacked, in addition to the other symptoms, with acute catarrh of the pharynx and middle ears. Here, also, a susceptibility to arsenic seemed to have been established, which, possibly, was greater from the fact that the patient had previously been poisoned.

Cases 5 and 6 were reported by Dr. Francis, of Brookline, the analyses being made, as in the last cases, by Dr. Wood. Neither case presented unequivocal signs, one of them being that of an infant, previously healthy, who refused food without apparent cause; and the other that of a young lady, who became extremely anæmic, and suffered from repeated attacks of diarrhœa, all symptoms disappearing promptly on removal from exposure, and taking tonic treatment.

Cases 6 and 7 were again husband and wife, and were reported to me by Dr. Comey, who made the analyses, and was in position to know all the facts with accuracy. One of the cases in particular, that of the husband, a gentleman of fifty, and of naturally good health, was remarkably interesting.

The symptoms included temporary impairment of memory, and mental vigor, albuminuria with casts and blood, and a prolonged painful affection of one foot, attended with excessive local coldness and pallor, and a sense of numbness, for which no cause could be found, but which improved under massage, and like the other symptoms, eventually passed away after removal of the patient from exposure to the arsenical paper. Not having seen the case myself, I do not feel at liberty confidently to refer this curious symptom to the source of the arsenic, but it is probable that, so far as the unsymmetrical position of the lesion is concerned, arsenic might have been the cause, or partial cause.

Dr. Comey's case is also important from the fact that arsenic continued to be eliminated in the urine, though in diminishing quantity, for nearly seven months after removal of the papers, while at the same time the steady decrease, and eventual complete disappearance, of the symptoms gave good grounds for thinking that the real source had been found. The objectionable papers, which were two in number, and were superposed one over the other, were, most of the time, covered in with a third, which was free from arsenic. The innermost paper contained fifteen grains per square meter. Cases where poisoning has apparently occurred under these circumstances have repeatedly been reported, and strongly support the view that the arsenic sometimes makes its way into the room in a volatile form. The most recent experiments of Hamberg, who has long investigated this question, would seem to show that this vapor is not arsenuretted hydrogen to any great extent, while the investigations of Selmi, and others, referred to by Stevenson, of Guy's Hospital, in the *British Medical Journal* for 1888, page 1220, suggest that the dangerous

compound may be one of the extremely poisonous "arsines" which are formed in the presence of decaying organic matter.

Cases 8 and 9 were contributed by Mr. W. S. Robinson, assistant in the chemical department at Cambridge, who made the analyses, as well as by Dr. E. C. Leach, in whose family they occurred, and by Dr. Knapp, who examined one of the patients. Characteristic symptoms were present in only one of the cases, that of a child, who presented ataxia, now a recognized symptom of neuritis. This affected especially the right side, and was associated with numbness, prickling of all four extremities, and also extreme nervous irritability. The other case, that of the mother, was also interesting because of a long-continued pain in the eyes not attended by any material amount of inflammation. The patient was for a time under the care of Dr. Hasket Derby for this symptom, and I should judge that he considered it of the nature of simple asthenopia. This view is perhaps strengthened by the fact that it recurred several times while the patient was away from home, though the tendency to it eventually passed nearly away. On the other hand, this also was one of the cases in which arsenic continued to be found in the urine, for many months after the suspected papers had been removed, either because elimination was delayed, or because all the sources of poisoning were not found. The amount of arsenic found in the worst paper was twenty grains per square yard, but this paper was covered by another which was free from arsenic. A recurrence or outbreak of symptoms after removal from exposure is not an uncommon event in the history of arsenical poisoning from whatever source. The characteristic paralyses, for example, sometimes appear days, weeks, and even

months after a single large dose, or a number of smaller doses, have been taken.

Cases 10 to 15 were contributed by Dr. Driver, of Cambridge, and Prof. Sanger.

Nos. 10 and 11 were two typical examples of the more usual form of poisoning, the symptoms consisting in impaired health for two years, then marked irritation of the eyes and throat, diarrhoea, and insomnia, all ending eventually in recovery. It is interesting that the urine of one of the patients, who stayed at home most of the time, contained twice as much arsenic as that of the other, her sister, who spent half of her time away, at work, the exposure being otherwise the same. The amounts were, respectively, 0.068, and 0.028 per litre.

Case 12 was interesting from the fact that here, also, there were periodic attacks of gastralgia, occurring, this time, at night, but in addition, occasional outbreaks of colic and diarrhoea. Insomnia and debility were also present. There were no other especially characteristic symptoms. The urine contained 0.01 mg. per litre.

In Case 13 arsenic was twice found in the urine, but it was difficult to say what symptoms, if any, were to be attributed to its influence. The case was one of severe and painful inflammation in the abdominal cavity, with constipation and loss of strength. It is, however, interesting to note that the only wall-paper was in the parlor. The family sat here a good deal, and it was so placed that the warm air, rising from this part of the house, could circulate freely through the chambers, which were not themselves papered. The parlor paper contained nine grains of arsenic to the square yard. The amount in the urine was, at the first analysis, 0.016; at the second, just one month later, 0.002 per litre.

Case 14, the patient being a lady of fifty-eight, showed, besides the more common symptoms of impaired nutrition and digestion, numbness of the hands at times, and weakness in walking. In the presence of these symptoms it is fair to suspect that a searching physical examination of the muscles, and of the sensibility of the skin, might have justified a diagnosis of neuritis. Without that, the numbness of the hands at least can only be counted as a corroborative symptom. The source of the arsenic was not traced out, but the patient improved on leaving home, and relapsed on her return. The amount of arsenic in the urine was 0.005 per litre.

In Case 15 the patient suffered from "epileptic vertigo," which was not, however, attributed to the arsenic. She had also obscure digestive and nervous symptoms. The suspected paper was not removed, and the patient did not recover. The amount found in the urine was 0.005 per litre.

In Case 16 a variety of serious symptoms were present referable to the nervous system and general nutrition, but Bright's disease was present, and for this reason it would not have been thought worth while to report this case, but that it is a question to be investigated whether arsenic may not occasionally set up a chronic nephritis. The quantity found in the urine was also relatively large, 0.055 per litre. The source of the arsenic was not discovered.

Case 17 was that of a school teacher, thirty-six years old, and in a rather nervous and debilitated state through her work, without, at first, any distinctly characteristic signs of arsenic poisoning. During the summer months immediately following this period she spent more of her time out of doors, and also changed her room, and seemed on the high road to recovery. In Oct. she returned to her former

room, and immediately her old symptoms came back, and she was obliged to keep her bed, suffering from ringing in the ears, sleeplessness, attacks of colic at night followed by diarrhœa, bad taste in the mouth, flatulent dyspepsia, irritation of the eyes and throat, and numbness of the hands. On account of the character of the symptoms, and because they became worse after the house was closed for a time, and the furnace lighted, arsenic was suspected and sought for. The paper in the room was found to contain only a trace, but a frieze twenty inches wide, and extending through three stories, gave fifteen grains to the square yard, and it was observed that the hallway formed a sort of shaft through which the heated air was conducted to the patient's bedroom, which was protected only by a portière, with an open space at the top. Furthermore, a small trunk-room, the door of which opened next to hers, and which was used, with its windows open, to ventilate her room, had an old paper, with border and figures of paris green. The urine contained 0.018 mg. of arsenic to the litre. The paper has been removed, and the patient's gastric symptoms and sleeplessness are much relieved, though she is still under treatment.

Cases 18 and 19 were communicated by Dr. T. M. Rotch, and are of interest from the fact that one of the patients, a child's nurse forty years of age was found to be suffering from a parenchymatous nephritis of very subacute character, at the same time that the other patient, the child himself, showed the general and mucous membrane symptoms of arsenical poisoning, both illnesses being traceable, in all appearance, to a certain paper. The child was, later, attacked with scarlet fever, and was isolated with his nurse in another room. The fever ran its usual course, without complications,

and the nurse rapidly recovered. The urine of both was found by Dr. Hills to contain arsenic before the removal, and none afterward.

Cases 20 to 24 were contributed by Dr. Nichols, of Cambridge, the analyses having been made by Prof. Hill. In the first case, that of a girl ten years of age, there were, besides sore throat, cough, and general debility with anæmia, frequent attacks of feverishness, — a symptom spoken of in the early part of this paper, as of occasional occurrence and somewhat characteristic. The patient improved during an absence, relapsed on returning home, and eventually recovered. In the second case, that of a boy four years old, the symptoms were not especially characteristic. The third case, or, rather, group of cases, was that of a mother and two children, five and four years old respectively. The symptoms were general in character, consisting in debility, indigestion, sore throat, cough, broken sleep. "Several of the wall-papers were moderately arsenical. In the girl's bedroom was a plain blue border about six inches wide, which contained nine grains of arsenic to the square yard."

There was marked improvement in the condition of the family after removal of the papers.

In the fourth set of cases, also a whole family, the mother and two or more children, were involved. The symptoms concerned the digestion and mucous membranes of the eyes and throat; and, in addition the mother suffered from palpitation and irregular action of the heart. Several papers were moderately arsenical, and that of the dining room contained more than ten grains to the square yard. Improvement began, in every case, on the removal of the papers.

The facts of interest brought forward by these cases have for the most part been noted in passing.

The analysis of the papers and urine were suggested as a rule either by prudence or remembrance of former experiences, or by the concurrence or unusual course of symptoms otherwise familiar; in a few cases by characteristic individual symptoms, the nature of the urinary sediment, profuse salivation with glandular inflammation, neuritis, attacks of feverishness, but in some of the cases the conspicuous absence of characteristic signs suggests that a routine examination might bring some interesting facts to light as to the frequency with which arsenic is absorbed under these conditions. In many cases, no doubt, it does no harm; in others it may only increase the general liability to disease.

None of the reporters speak of the discoloration of the skin, nor of painful micturition, or distinctly periodic symptoms, except that nightly attacks of gastralgia were noted in Case 12, but possibly these symptoms were not sufficiently sought for. Notwithstanding the diagnostic value of a urine-analysis in suspected cases, it is not to be forgotten that a failure to find arsenic in this way is not a positive proof that it is not present in the body, since, as Taylor and others have shown, arsenic may be excreted only intermittently by the kidneys, and even in acute fatal cases the urine has been found to be free. Kirchgasser (*loc. cit.*) reports a case where, after a failure to find arsenic in the urine at the end of six weeks after cessation of the exposure, he waited two weeks more, and then collected ten pounds of fæces, and in this way obtained abundant evidence that arsenic was still being given off.

Potassic iodide is supposed to favor the excretion of arsenic by the kidneys, but if this is true it would seem that it must be by increasing the secretion only, for it is difficult to see on what other principle the drug should act, and perhaps for this

purpose other drugs would answer as well or better. One other observation of Kirchgasser's is worthy of note as concerning the differential diagnosis, namely, that he has seen an increase, instead of a falling off, of fat and weight, as a result of exposure to arsenical wall-papers, in the interval between two outbreaks of symptoms. This result is well known to attend the use of arsenic in large but non-poisonous doses.

With regard to the electrical examinations of suspected cases, I would only say that the electrical reactions of neuritis are reported as usually diminished to both currents, but sometimes normal, and sometimes even exaggerated. Of these changes, the exaggeration is probably temporary, though characteristic when present. The diminution to both currents is more common, but might easily escape attention unless carefully sought for, and it may precede any apparent loss of strength. With regard to the alleged finding of truly normal reactions in cases of neuritis where there is diminished motor power, I feel rather sceptical, and doubt whether the examination was made with sufficient care. The reactions in affections attended by even such slight disorders of the nutrition as cases of the so-called writer's cramp present, are rarely normal, though they would no doubt be called so, if close study had not shown that slight changes in one direction or the other can almost invariably be detected.

It will be interesting to investigate briefly, among these twenty-two cases where arsenic was found in the urine, for any facts of special interest as to the source from which it was derived.

In three cases the whole or main source was apparently an arsenical paper covered in by another free from arsenic. This condition of affairs has

now been reported too often to be attributed to coincidence.

Kirchgasser found it in several of his cases where arsenic was present in the urine.

A layer of varnish, paper, or paint gives temporary, though perhaps only relative, protection; but cracks, erosion, and dampness soon seem to make this inadequate, especially, no doubt, if the quantity in the underlying paper is large, as in Dr. Comey's case, where it amounted to fifteen grains per square yard.

Arsenical friezes seem to have been dangerous neighbors in two cases. In more than half the cases the arsenical paper was wholly or mainly in bedrooms. In two cases the worst paper was not that of the bedroom, and in one it was in a spare room but little used by the family, though its door was open and it was included in the spring cleaning, at which time there was exacerbation of symptoms. In Dr. Torrey's case not only the papers, but a dress and a number of fabrics, were found to contain arsenic.

Finally, I desire to present a few facts tending to show that under certain as yet undetermined conditions the elimination of arsenic may not go on so rapidly as is usually the case. If this is true, it may explain the occasional delay in the outbreak of symptoms.

The time usually considered sufficient for the complete elimination of arsenic is twelve to twenty days, but some chemists place the extreme limit, in the case of man, at six weeks, and traces have been found in the tissues of animals after forty days. The subject seems to me of so much importance, with relation to the occasional late appearance and long continuance of certain symptoms of poisoning, that I venture to offer a few facts to show that elimination may sometimes be delayed.

Even Taylor ("On Poisons"), while asserting the general principle of rapid elimination, admits by inference that the process may be delayed if the eliminating organs are working as they should.

1. Two cases have already been reported (Cases 6 and 8) where the elimination was apparently going on for seven to nine months after cessation of the exposure, though it must be admitted that this class of cases is not suitable for conclusively settling such a point. The steady improvement and eventual recovery of the patient seemed to indicate that the real cause had been found, but it is possible that absorption went on for a time from the accumulations in the air of the house, or in the form of dust.

2. A similar case to these, with elimination continuing for three months, is given by Kjellberg.³

3. A case of poisoning from medicinal doses is cited in a paper previously published by myself,⁴ where the arsenic did not disappear from the urine for nearly fifty days.

4. A case is reported above (Kirchgasser) showing that the *faeces* may contain arsenic after elimination by the kidney has ceased.

5. The most important case is one given by Gibb in the Transactions of the Pathological Society of London,⁵ where traces of arsenic were found in the liver and bones six months after cessation of a long course of medicinal treatment which had led to paralysis and eventually to death.

One reason, perhaps, that it has been so strongly asserted that arsenic does not accumulate is that it has been supposed that arsenic did not form definite compounds with the albuminoid tissues of

³ Hygeia, 1881, cited in Virchow, and Hirsch's J. ber., 1882, i. 398.

⁴ Boston Med. and Surg. Jour., 1888, vol. ii. p. 1.

⁵ See the Boston Med. and Surg. Jour., 1888, ii. p. 1.

the body. This view is, however, disproved by the recent experiments of Dogiel, the last series of which are reported in the Transactions of the International Congress at Copenhagen in 1884.

